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Mortality of False Chinch Bug, *Nysius raphanus* (Howard), to Selected Insecticides

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Abstract: In the laboratory bioassays, a two-year study was conducted to evaluate mortality of False Chinch Bug (FCB), *Nysius raphanus* (Howard) (Hemiptera: Lygaeidae), to selected insecticides. All treatments caused significantly FCB mortality in both years. In the first year, diazinon and chlorpyrifos were significantly more effective insecticides than other insecticides. A thiamethoxam and spinosad were the least effective insecticides. In the second year, permethrin, thiamethoxam, endosulfan and chlorpyrifos were the most effects insecticides for causing on FCB mortality at 24 h, while an esfenvalerate, lambda-cyhalothrin and imidacloprid were less effective insecticides.

Key words: False chinch bug, *Nysius raphanus* (Howard) (Hemiptera: Lygaeidae), insecticides, mortality

INTRODUCTION

The False Chinch Bug (FCB), *Nysius raphanus* (Howard) (Hemiptera: Lygaeidae), is one of the most serious pests among North American species of *Nysius* (Sweet, 2000). The bug is multivoltine (Burgess and Weegar, 1986) and overwinters as adults under protective debris or rubbish (Burgess and Weegar, 1986; Sweet, 2000). It is a general feeder with preference for plants in the Chenopodiaceae and Brassicaceae (Capinera, 2002; Demirel and Cranshaw, 2006a-c). False chinch bugs cause significant injury at all growth stages of canola, particularly following flowering and during seed-pod development (Demirel and Cranshaw, 2005, 2006a-c).

False chinch bug has been controlled with foliar applications of insecticides (Capinera, 2002). Spot treatments often are the best approach because FCB tends to be highly aggregated on some plants or some places of the field (Young and Teetes, 1977). Very few published insecticide trials have included false chinch bug. The earliest reported trials to control false chinch bug involved dust formulations of heptachlor, aldrin, toxaphane and endrin, all of which resulted in effective control for the false chinch bug (Wene, 1958). In addition, five percent malathion and 0.1% impregnated pyrethrum dust also provided control.

Leigh (1961) conducted two different trials under field and laboratory conditions. In field experiments endrin and heptachlor gave satisfactory control, while Sevin (1-naphthyl methylcarbamate) was relatively ineffective. In laboratory trials, malathion was the most effective compound. Dieldrin, endrin and trichlorf were about equally effective against for false chinch bug, while toxaphene and DDT were relatively ineffective. The most recent report by Demirel and Cranshaw (2006b) sprays of permethrin applied to the bags significantly reduced numbers of FCB for at least 12 days after application. Therefore, this reduction resulted in a 25-79% increase in yields compared with untreated bags.

The purpose of this study was to evaluated mortality of false chinch bug, *Nysius raphanus* (Howard), to selected insecticides in the laboratory bioassays.

MATERIALS AND METHODS

Insecticide Bioassay

This study was conducted on 23-August in 1999 in Fort Collins, Colorado (USA). Five concentrations of thiamethoxam, cyfluthrin, diazinon, chlorpyrifos and lambda- cyhalothrin were impregnated on filter paper, placed in Petri dishes (100×15 mm) following which adult FCB collected on canola plants using a sweep net. Similarly the toxicity of spinosad was assessed at three different concentrations. Mortality was assessed at 24 and 48 h and analyzed using the Student-Newman-Keuls (SNK) Multiple Comparison Tests ($p<0.05$, SAS Institute Inc., 1998). In the following year, study was conducted on 27-June and thiamethoxam, diazinon, chlorpyrifos, endosulfan, esfenvalerate, lambda-cyhalothrin, imidacloprid, permethrin and spinosad were assessed in similar bioassays, but evaluations were continued up to 72 h after treatment.

RESULTS AND DISCUSSION

Insecticide Bioassay

All treatments caused a significant the FCB mortality in both years (Table 1 and 2). In the first year, the highest concentration of diazinon and chlorpyrifos resulted in significant FCB mortality (Table 1). For example, a diazinon 0.1 and 0.01 concentration caused 95 and 96% mortality at 24 h ($F = 24.141$, $df = 4, 20$, $p = 0.0001$) and also the same and 0.001 concentration having 100% mortality at 48 h ($F = 5.631$, $df = 4, 20$, $p = 0.003$). In addition, the chlorpyrifos resulted in 85, 92, 89 and 78% mortality with 0.1, 0.01, 0.001 and 0.0001 concentration at 24 h ($F = 18.031$, $df = 4, 20$, $p = 0.0001$) and three times 100 and 93% at 48 h ($F = 6.518$, $df = 4, 20$, $p = 0.002$).

Table 1: Mortality of selected insecticides to *N. raphanus* at laboratory bioassay in 1999

		Percent of mortality (±SE)[z]	
Insecticides	Exposed doses (μg mL^{-1})	24 h	48 h
Diazinon	0.1	94.95 (±2.56)a	100.0 (±0.00)a
	0.01	96.25 (±1.74)a	100.0 (±0.00)a
	0.001	70.69 (±6.53)b	100.0 (±0.00)a
	0.0001	45.73 (±3.55)c	85.88 (±5.38)b
	0.00001	40.65 (±8.82)c	86.23 (±4.77)b
Chlorpyrifos	0.1	85.25 (±3.10)a	100.0 (±0.00)a
	0.01	92.40 (±2.21)a	100.0 (±0.00)a
	0.001	88.92 (±3.55)a	100.0 (±0.00)a
	0.0001	77.53 (±7.20)a	92.80 (±0.98)a
	0.00001	48.08 (±3.04)b	82.90 (±6.50)b
Cyfluthrin	1	71.81 (±6.05)a	80.87 (±2.47)a
	0.1	47.79 (±4.84)b	70.25 (±5.60)a
	0.01	34.47 (±3.65)bc	51.60 (±4.64)b
	0.001	43.94 (±3.71)b	54.42 (±6.20)b
	0.0001	26.43 (±3.12)c	35.61 (±4.13)c
Lambda-cyhalothrin	0.1	74.86 (±5.28)a	91.77 (±1.20)a
	0.01	57.01 (±3.88)b	86.74 (±2.29)a
	0.001	45.46 (±3.90)b	68.29 (±6.31)b
	0.0001	29.92 (±4.26)c	62.01 (±8.03)b
	0.00001	21.42 (±2.83)c	44.91 (±4.81)c
Thiamethoxam	1	69.94 (±4.22)a	86.93 (±2.33)a
	0.1	48.71 (±5.98)b	73.81 (±7.64)ab
	0.01	29.78 (±3.79)c	63.41 (±5.52)b
	0.001	16.24 (±7.22)c	29.03 (±8.54)c
	0.0001	11.86 (±4.85)c	28.37 (±5.83)c
Spinosad	0.2	28.11 (±2.56)b	44.05 (±1.76)c
	2	32.31 (±3.37)b	60.45 (±6.06)b
	20	48.12 (±6.85)a	79.31 (±2.82)a

[z]Numbers within a column not followed by the same letter(s) are significantly different ($p<0.05$) by SNK

Table 2: Mortality of selected insecticides to *N. raphanus* at laboratory bioassay in 2000

Insecticides	Exposed dose (μg mL^{-1})	Percent of mortality (±SE)[y] 24 h	48 h	72 h
Diazinon	0.1	98.30 (±1.69)a	100.0 (±0.00)a	100.0 (±0.00)a
	0.01	95.32 (±3.86)a	100.0 (±0.00)a	100.0 (±0.00)a
	0.001	59.10 (±6.91)b	74.33 (±3.90)ab	84.23 (±2.47)ab
	0.0001	41.49 (±10.85)b	47.96 (±11.76)b	66.87 (±8.85)bc
	0.00001	35.98 (±17.24)b	44.32 (±14.73)b	57.88 (±10.89)c
Chlorpyrifos	0.01	93.63 (±2.63)a	100.0 (±0.00)a	100.0 (±0.00)a
	0.001	96.87 (±3.12)a	100.0 (±0.00)a	100.0 (±0.00)a
	0.0001	97.72 (±2.27)a	100.0 (±0.00)a	100.0 (±0.00)a
	0.00001	89.86 (±10.13)a	98.64 (±1.35)a	100.0 (±0.00)a
	0.000001	32.26 (±10.76)b	54.96 (±7.41)b	79.18 (±7.12)b
Endosulfan	1	98.17 (±1.82)a	100.0 (±0.00)a	100.0 (±0.00)a
	0.1	98.52 (±1.47)a	100.0 (±0.00)a	100.0 (±0.00)a
	0.01	96.80 (±3.19)a	100.0 (±0.00)a	100.0 (±0.00)a
	0.001	65.43 (±11.65)ab	86.37 (±4.90)a	91.32 (±2.62)b
	0.0001	41.62 (±20.48)b	50.03 (±20.28)b	86.30 (±3.46)b
Esfenvalerate	1	97.40 (±2.59)a	98.70 (±1.29)a	100.0 (±0.00)a
	0.1	87.82 (±2.23)a	91.42 (±2.31)a	94.19 (±2.63)a
	0.01	23.87 (±11.40)b	38.59 (±12.50)b	55.28 (±7.21)b
	0.001	12.64 (±5.89)b	33.48 (±14.01)b	52.05 (±15.41)b
	0.0001	16.19 (±6.65)b	31.54 (±13.00)b	53.75 (±8.00)b
Lambda-cyhalothrin	1	89.04 (±8.58)a	94.49 (±4.68)a	100.0 (±0.00)a
	0.1	88.34 (±1.30)a	94.17 (±0.65)a	100.0 (±0.00)a
	0.01	81.40 (±5.87)a	95.21 (±2.80)a	97.93 (±1.32)a
	0.0001	30.01 (±12.41)b	49.32 (±7.74)b	66.46 (±6.81)b
	0.00001	29.02 (±12.12)b	45.92 (±15.34)b	63.55 (±9.61)b
Permethrin	1	100.0 (±0.00)a	100.0 (±0.00)a	100.0 (±0.00)a
	0.1	94.64 (±5.35)a	100.0 (±0.00)a	100.0 (±0.00)a
	0.01	86.16 (±8.66)a	99.35 (±0.64)a	100.0 (±0.00)a
	0.001	92.02 (±4.70)a	95.49 (±2.67)a	100.0 (±0.00)a
	0.0001	62.02 (±12.70)b	79.57 (±7.54)b	85.37 (±6.14)b
Imidacloprid	1	91.10 (±3.80)a	99.43 (±0.56)a	100.0 (±0.00)a
	0.1	81.03 (±9.48)a	96.00 (±4.00)a	100.0 (±0.00)a
	0.01	62.72 (±6.68)a	72.03 (±6.39)ab	97.27 (±2.72)a
	0.001	24.21 (±11.97)b	43.85 (±12.02)bc	57.53 (±13.48)b
	0.0001	17.13 (±16.06)b	28.70 (±19.06)c	39.97 (±17.02)b
Thiamethoxam	1	100.0 (±0.00)a	100.0 (±0.00)a	100.0 (±0.00)a
	0.1	96.32 (±3.67)a	100.0 (±0.00)a	100.0 (±0.00)a
	0.01	77.19 (±15.66)a	87.09 (±11.08)a	94.36 (±4.72)a
	0.001	1.85 (±3.70)b	4.31 (±2.44)b	16.17 (±4.08)b
	0.0001	3.52 (±1.63)b	7.52 (±3.77)b	21.83 (±8.70)b
Spinosad	0.2	64.71 (±10.87)a	76.83 (±5.32)b	87.35 (±2.18)b
	2	96.01 (±2.40)a	100.0 (±0.00)a	100.0 (±0.00)a
	20	78.60 (±11.31)a	100.0 (±0.00)a	100.0 (±0.00)a

[y]Numbers within a column not followed by the same letter(s) is significantly different ($p<0.05$) by SNK

The others treatments also caused significant FCB mortality during application periods. A cyfluthrin resulted in 72 and 81% mortality with its higher concentration ($F = 15.247$, $df = 4, 20$, $p = 0.0001$; $F = 13.364$, $df = 4, 20$, $p = 0.0001$, respectively). In addition, the lambda-cyhalothrin caused 75% mortality with 0.1 concentration at 24 h and 92 and 87% mortality with 0.1 and 0.01 concentration at 48 h ($F = 26.901$, $df = 4, 20$, $p = 0.0001$; $F = 13.470$, $df = 4, 20$, $p = 0.0001$, respectively). A thiamethoxam also caused 70 and 87% mortality its highest concentration at 24 and 48 h ($F = 20.172$, $df = 4, 20$, $p = 0.0001$; $F = 17.483$, $df = 4, 20$, $p = 0.0001$, respectively). The spinosad resulted in 79% mortality with 20 concentration at 48 h ($F = 19.522$, $df = 2, 12$, $p = 0.0001$). In the second year, permethrin and thiamethoxam caused a 100% mortality with their highest concentration at 24 h ($F = 3.816$, $df = 4, 15$, $p = 0.025$; $F = 45.762$, $df = 4,15$, $p = 0.0001$, respectively) (Table 2). The most consistent mortalities were observed by endosulfan and chlorpyrifos. An endosulfan resulted in 98, 99 and 97% mortality with 1, 0.1 and 0.01 concentrations at 24 h and 100% mortality at 48 and 72 h (F = 5.778, df = 4,15, p = 0.005; F = 5.375, df = 4,15, p = 0.007; F = 10.737, df = 4,15, p = 0.0001, respectively). In addition, the chlorpyrifos resulted in 94, 97, 98% at 24 h and 100% mortality at 48 and 72 h (F = 16.317, df = 4,15, p = 0.0001; F = 35.240, df = 4, 15, p = 0.0001; F = 8.543, df = 4,15, p = 0.001, respectively). The diazion, permethrin, thiamethoxam and spinosad caused 100% mortality with their first and second higher concentrations at 48 h (F = 9.804, df = 4, 15, p = 0.0001; F = 5.946, df = 4, 15, p = 0.005; F = 85.538, df = 4, 15, p = 0.0001; F = 33.606, df = 2, 9, p = 0.0001, respectively). An esfenvalerate resulted in 100% mortality with the highest concentration at 72 h (F = 7.904, df = 4, 15, p = 0.001). In addition, lambda-cyhalothrin and imidacloprid caused 100% mortality with first and second higher concentration at 72 h (F = 12.598, df = 4,15, p = 0.0001; F = 8.346, df = 4, 15, p = 0.001, respectively). Moreover, chlorpyrifos and permethrin caused 100% mortality with four different concentrations at 72 h.

There are very few published insecticide trials have included false chinch bug. Far more studies have been conducted on other lygaeids, notably chinch bugs (*Blissus* sp.), *Oxycarenus lavaterae* F. and *Geocoris punctipes* (Say). For example, foliar applications of ethyl parathion, carbaryl, carbofuran and Penncap M (encapsulated methyl parathion) significantly reduced numbers of *B. leucopterus leucopterus* (Say) on sorghum (Wilde and Morgan, 1978; Mize *et al*., 1980; Bauernfeind, 1987). Post emergence application of phorate granules and chlorpyrifos spray to corn reduced chinch bugs over 90% in one experiment during the first week (Peters, 1983). However, carbofuran and carbaryl sprays were less effective in wheat. The best control of *B. l. leucopterus* on wheat was obtained with phorate granules with ca. 58% control (Peters, 1983). Bauernfeind (1987) also reported that treatments of fenvalerate, parathion, endrin and chlorpyrifos provided acceptable kill (at least 90% population reduction) within the first 24 h after their application. More recent studies done by Castro and Riley (1999) found effective control with cyfluthrin, deltamethrin, carbofuran, lambda cyhalothrin, chlorpyrifos and fipronil. Sears *et al*. (1980) reported that a number of the insecticides were evaluated over a 5-year period for control of hairy chinch bug, *Blissus leucopterus hirtus* Montandon. They concluded that diazinon at 2-4 kg AI ha^{-1} and chlorpyrifos provided the most consistent control. Carbaryl, Aspon and methidathion were effective at higher tested rates, while chlordane was ineffective. Also the best time of treatment was early in the season when most of the hairy chinch bugs were in the 3rd instar. This gave better control than application made to later stages. The southern chinch bug, *B. insularis*, also is an important pest of turfgrass in the southern United States (Sweet, 2000). Propoxur and fenvalerate and permethrin provided good control of southern chinch bug populations on lawns (Reinert, 1982). Nagata and Cherry (1999) reported that survival of different life stages of the southern chinch bug measured after insecticidal applications of acephate, chlorpyrifos and lambda-cyhalothrin. Adults and nymphs were killed with all three insecticides sprayed at recommended field rates. Nagata *et al*. (2002) also reported on insecticidal treatments made using chlorpyrifos for control of southern chinch bugs.

In summary, in the first year, diazinon and chlorpyrifos were significantly most affect for causing FCB mortality comparing with other insecticides. A thiamethoxam and spinosad were the least effects to cause on FCB mortality. In the second year, permethrin, thiamethoxam, endosulfan, chlorpyrifos were the most effects insecticides to cause on FCB mortality at 24 h. An esfenvalerate, lambda-cyhalothrin and imidacloprid were less effect insecticides to cause on FCB mortality.

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